Measurement Of Carbon Dioxide In Corn Cob Biochar-amended Acid Soil Added With Different Types Of Fertilizers

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MS SOIL SCIENCE
What we will learn...

• Why biochar?
• CO₂ sequestration
• CO₂ evolution trends
• Effect in the environment
What is Biochar?

- Biochars are new, carbon-rich materials that could sequester carbon in soils.
- Improves soil properties and agronomic performance.
- Inspired by investigations of Terra Preta in Amazon.

Biochar

- The pyrolysis conversion of waste biomass into biochar is particularly attracting attention for the following two reasons.
- it can be used as a soil amendment for improving soil quality and,
- storing biochar in soils is regarded as a mean for permanently sequestering carbon.

Biochar

- environment-related benefits linked with biochar
- rehabilitation of degraded lands,
- reduced GHG emissions,
- adsorption of contaminants to offset streams, and groundwater pollution are among the
- It is well documented that biochar application into soil can reduce the emission of CO2, CH4, and N2O.

What is biochar?

*Biochar* is a highly porous material made from organic waste. Can be any forest, agricultural, or animal waste.

**Examples:**
- Woodchips
- Corn husks
- Peanut shells
- Chicken manure

More about biochar..

- Biochar is a carbon-rich solid material produced by heating biomass in an oxygen-limited environment.

- Intended to be added to soils as means to sequester carbon (C) and maintain or improve soil functions.

- It is produced after pyrolysis of biomass, typically within a temperature range of 300°C to 800 °C.

Are all biochars the same?
Biochar and Agriculture

Biochar and Agriculture

Gasifier Inno-technology for Negative Carbon Production (GIN-P) pyrolytic cook stove
Benefits of Biochar

Benefits of Biochar

Biochar and CO2 Sequestration

- biochar is a highly stable form of carbon and as such has the potential to form an effective C sink, therefore sequestering atmospheric CO2.

Objectives

This experiment was conducted to give a close attention to the Effect Corn Cob Biochar on the Rate of Carbon Sequestration in Red Acidic Soil

- compare the CO2 evolution trends of all treatments

- compare the sequestration rates
Materials and Methods
Preparation of Treatments

Treatments are as follows:
Treatment 1: Control (soil alone)
Treatment 2: T1 + biochar (10t/ha)
Treatment 3: T1 + *Gliricidia sepium* leaves
Treatment 4: T3 + biochar (10t/ha)
Treatment 5: T1 + rice straw
Treatment 6: T5 + biochar (10t/ha)
Treatment 7: T1 + inorganic fertilizer
Treatment 8: T7 + biochar (10t/ha)
Treatment 9: T1 + organic fertilizer (5t/ha)
Treatment 10: T9+ biochar (10t/ha)
Materials and Methods
Determination of Carbon Dioxide Evolution

- 50 ml beaker with 30ml 0.3N NaOH
- Incubation jar
- Iron mesh to support the beaker
- Cap to prevent CO2 from diffusing from the jar
- Sample
Materials and Methods
Determination of Carbon Dioxide Evolution
Materials and Methods
Duration and Titration Schedule

- Titration was done in 2, 5, 7, 14, 21 and 28 days interval respectively.
Materials and Methods
Determination of Carbon Dioxide Evolution

Results were expressed as mg carbon dioxide produced per 100 grams soil. The formula used in calculating the carbon dioxide evolved was:

\[ mg \text{ of } CO_2 = \frac{(B-V) \times 22 \times N \times 2}{T} \]

where:

\( V \) = Volume (mL) of acid used to titrate
\( B \) = Volume (mL) of acid used to titrate the CO\(_2\) trap to the end point
\( N \) = Normality of the acid
\( T \) = Time (in days)
\( 22 \) = weight of 1 meq CO\(_2\) in mg
## Results

### Chemical Properties of Luisiana Clay

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.68</td>
</tr>
<tr>
<td>EC</td>
<td>0.049</td>
</tr>
<tr>
<td>N</td>
<td>2.75 (M)</td>
</tr>
<tr>
<td>P</td>
<td>6.24 (L)</td>
</tr>
<tr>
<td>K</td>
<td>0.08 (D)</td>
</tr>
</tbody>
</table>

$L = Low \quad M = Medium \quad H = High \quad D = Deficient \quad S = Sufficient$
## Results

### Chemical Properties of Corn Cob Biochar

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td>1.29</td>
</tr>
<tr>
<td>P (%)</td>
<td>0.67</td>
</tr>
<tr>
<td>K (%)</td>
<td>2.70</td>
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<tr>
<td>Ca (%)</td>
<td>0.22</td>
</tr>
<tr>
<td>Mg (%)</td>
<td>0.51</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>1024</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>220</td>
</tr>
<tr>
<td>Cu (ppm)</td>
<td>14</td>
</tr>
<tr>
<td>Mn (ppm)</td>
<td>85</td>
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</tbody>
</table>
Energy Dispersive Spectroscopy (EDS) For Transmission Electron Microscope (TEM)

<table>
<thead>
<tr>
<th>Element</th>
<th>Wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>88.4</td>
</tr>
<tr>
<td>Copper</td>
<td>5.4</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.7</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.7</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.5</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.2</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.2</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.2</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.1</td>
</tr>
</tbody>
</table>
# Corn Cob Biochar Surface Area

## Data Reduction Parameters Data

<table>
<thead>
<tr>
<th>Adsorbate</th>
<th>Molec. Wt.</th>
<th>Temperature</th>
<th>Cross Section</th>
<th>Liquid Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>28.013</td>
<td>77.350K</td>
<td>16.200 Å²</td>
<td>0.808 g/cc</td>
</tr>
</tbody>
</table>

## Multi-Point BET Data

<table>
<thead>
<tr>
<th>Relative Pressure [P/Po]</th>
<th>Volume @ STP [cc/g]</th>
<th>1 / [W((Po/P) - 1)]</th>
<th>Relative Pressure [P/Po]</th>
<th>Volume @ STP [cc/g]</th>
<th>1 / [W((Po/P) - 1)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03120e-02</td>
<td>1.2068</td>
<td>3.5124e+01</td>
<td>2.03551e-01</td>
<td>2.5875</td>
<td>7.9030e+01</td>
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<tr>
<td>1.00689e-01</td>
<td>1.8962</td>
<td>4.7399e+01</td>
<td>2.54369e-01</td>
<td>2.8317</td>
<td>9.6392e+01</td>
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<tr>
<td>1.51140e-01</td>
<td>2.2726</td>
<td>6.2686e+01</td>
<td>3.04006e-01</td>
<td>3.0191</td>
<td>1.1576e+02</td>
</tr>
</tbody>
</table>

**BET summary**

- **Slope** = 318.036
- **Intercept** = 1.631e+01
- **Correlation coefficient, r** = 0.997370
- **C constant** = 20.495

**Surface Area** = 10.416 m²/g
Corn Cob Biochar Pore Radius

Analysis
- Operator: quantachrome
- Sample ID: corn cob
- Sample Desc: black powder
- Sample weight: 0.1192 g
- Outgas Time: 3.0 hrs
- Analysis gas: Nitrogen
- Pressure: 0.1000 100 (adsorbed)
- Analysis Time: 228.6 min
- Cell ID: 9

Report
- Date: 2017/03/28
- Operator: quantachrome
- File: CORN COB.gps
- Comment: Pore Size Analysis
- Sample Volume: 0.03066 cc
- OutGas Temp: 300.0 C
- Bath Temp: 273.0 K
- Equal Time: 60960 sec (adsorbed)
- End of run: 2017/03/28 18:46:32
- Instrument: Nova Station B

BJH Pore Size Distribution Desorption Data

Data Reduction Parameters Data
- t-Method: BJH
- Method: de Boer
- Moving pt. avg.: on
- Nitrogen: Ignoring P-tags below 0.35 P/Pr
- Temperature: 77.35°K
- Cross Section: 0.200 μ
- Liquid Density: 0.806 g/cc

<table>
<thead>
<tr>
<th>Radius [Å]</th>
<th>Pore Volume [cc/g]</th>
<th>Pore Surf Area [m²/g]</th>
<th>dV(r) [cc/A]</th>
<th>dS(r) [m²/A]</th>
<th>dV(logr) [cc/g]</th>
<th>dS(logr) [m²/g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.3348</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
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<tr>
<td>17.1528</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
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<td>0.000000e+00</td>
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<tr>
<td>19.1571</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
<td>0.000000e+00</td>
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<tr>
<td>32.5186</td>
<td>1.1266e-04</td>
<td>1.043e-04</td>
<td>1.043e-04</td>
<td>4.165e-02</td>
<td>2.116e-03</td>
<td>2.099e-04</td>
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<tr>
<td>47.4385</td>
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<td>1.043e-04</td>
<td>1.043e-04</td>
<td>4.165e-02</td>
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<td>2.099e-04</td>
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<tr>
<td>151.5766</td>
<td>5.964e-04</td>
<td>1.450e-03</td>
<td>1.450e-03</td>
<td>3.814e-04</td>
<td>2.754e-03</td>
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<tr>
<td>338.4845</td>
<td>1.379e-03</td>
<td>2.145e-03</td>
<td>2.145e-03</td>
<td>1.143e-02</td>
<td>5.1437e-03</td>
<td>5.1437e-03</td>
</tr>
</tbody>
</table>

Surface Area = 0.230 m²/g
Pore Volume = 0.000 cc/g
Pore Radius Dv(r) = 21.495 Å
Results

Cumulative CO$_2$ evolution during the decomposition of organic materials with and without added biochar.
Total CO$_2$ evolved after 28 days incubation period.
Results and Discussion

Results such as these showed that biochar addition can capture C into the soil even in short period of time and confirmed its use in the long term storage of atmospheric CO$_2$ that may mitigate or defer global warming.
Conclusion

The addition of biochar with organic and inorganic fertilizers in an acidic red soil showed a decrease of CO\textsubscript{2} evolution in the soil.

Findings such as these can be assumed that incorporated biochar helps to capture CO\textsubscript{2} when added into the soil.
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